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Journal Item

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Abstract: Since their introduction in the USA in 2002, contactless card payment systems have been widely regarded as the pinnacle of current retail banking technology. However, the potential demand and usage of this innovation has hitherto received little attention from the academic community. Ours is one of the first papers that explore the factors that are likely to govern acceptance and intentions to take-up the technology. The analysis utilises the methodological framework of the technology acceptance model (Davis, 1989; Davis et al., 1989) and develops a range of empirical representations. Our results lend support to the TAM conceptualisation and also indicate that some demographic characteristics imprint upon the intentions of potential users.

Keywords: contactless cards; debit cards; radio frequency identification; RFID; technology acceptance model; TAM; retail payments; Polish banking.

Reference to this paper should be made as follows: Polasik, M., Wisniewski, T.P. and Lightfoot, G. (2012) 'Modelling customers' intentions to use contactless cards', *Int. J. Banking, Accounting and Finance*, Vol. 4, No. 3, pp.203–231.

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1 Introduction

This paper explores customer preferences regarding the latest innovation in the field of proximity-type payments, namely contactless cards. Point of sale (POS) transactions are estimated to generate net costs between 0.49% and 0.65% of GDP (Brits and Winder, 2005; Gresvik and Haare, 2009) and there is considerable debate as to which payment method (cash, debit or credit cards) is most efficient for different transaction values. With such potential financial incentives, it is no surprise that there is considerable demand for research that examines social propensity to utilise different payment technologies. Over the last year, a number of studies employing a range of different methodologies have been undertaken in the Netherlands (Bolt et al., 2009), Germany (Von Kalckreuth et al., 2009), Finland (Leinonen, 2008) and the USA (Borzekowski and Kiser, 2008). To date, however, there is a notable lack of data in the rapidly developing markets of Eastern Europe, despite the rapid changes that have occurred across the banking sector in this region over the past two decades.

The process of crowding-out cash by other, electronic, forms of payment has encountered many obstacles relating both to economic reasons and social mores. New technological innovations in the field of payment methods are seen to offer opportunities to surpass these barriers. However, existing systems already enjoy incumbent advantages, including strong network effects and economies of scale (Van Hove, 1999; Chakravorti, 2003; Gowrisankaran and Stavins, 2004; Bolt and Humphrey, 2007). New technological entrants to this field need to be accepted by clients and merchants alike, while meeting the substantial costs involved in introducing a new infrastructure of payment terminals (Levitin, 2007). Only a limited number of developments can hope to win widespread acceptance: the contactless card system, with its possibilities of competing effectively with cash for low-value transactions is seen as one such (Eastwood, 2008).

The contactless card is merely the latest iteration of a long line of payment instruments that can be traced back to the metal 'charga-plate' systems deployed by large retailers in the USA before the outbreak of WWII [Phelps, (1947), pp.147–150]. Although they had obvious similarities with contemporary credit cards, they could only be used to purchase items from the issuing retailer [Ritzer, (1995), pp.33–34]. Post

WWII, payment cards enjoyed dynamic growth as they became useable across different outlets. Diners Club pioneered a paper-based universal 'travel and entertainment' payment card in 1950 [Frazer, (1985), p.266] and their success encouraged others – most notably American Express in 1958. It is generally accepted that the first *bank* card was that issued by Franklin National Bank of Long Island in 1951 [Ritzer, (1995), pp.36–37; Mayes and Markantonakis, (2008), p.116]. The 1960s and 1970s saw the development of a range of payment card organisations and the general acceptance of cards by merchants. At this time, the transactions were not electronic; rather information from the card was recorded on paper by the merchant, who then sought telephone authorisation from the issuing bank.

In 1971, technological advances brought about the introduction of the magnetic strip on cards in the USA [Frazer, (1985), p.267] with the complementary pioneering of automated teller machines (ATMs) by Barclays Bank in 1967 (Bàtiz-Lazo and Wood, 2002; Bàtiz-Lazo and Wardley, 2007), further increasing cards functionality and popularity. The next step was the inclusion of a microprocessor on cards, with the first widespread trial from Cartes Bancaire in France in 1992 (Flier et al., 2001). Microprocessors were also used in the launch of e-purses throughout Europe in the 1990s. A milestone was reached in the evolution of the microprocessor-based cards with the adoption in 1999 of a common standard, EMV (standing for Europay, Mastercard and Visa – the principal architects) (Ward, 2006) that offered higher levels of security, longer lifespan, and the possibility of installing additional applications on the card (Ward, 2006). Before EMV, card fraud was increasing rapidly (Mayes and Markantonakis, 2008; Worthington, 2009), primarily due to card skimming – the practise of stealing the data held on the magnetic strip on a debit or credit card [see Riem (2001) and Stender and Schosheim (2007) for a more detailed description] and EMV cards are resistant to such crimes. However, it should be stressed that the USA did not sign up to this otherwise global standard.

The next evolutionary step in the small-value transaction market was the introduction of radio frequency identification (RFID) contactless technology. The first application of this technology for payments was with the Octopus system in 1997 for the Hong Kong's public transport network (Lefebre, 1999) and RFID smart card ticketing systems have been widely and successfully deployed, particularly in Asia. Contactless payment cards for more general banking purposes can be traced back to the introduction of the Mastercard *PayPass* in Orlando, Florida in 2002 by JP Morgan Chase, Citigroup and MBNA (Capizzi and Ferguson, 2005). Globally, according to Polasik et al. (2009) and Polasik et al. (2011b), there were around 70 million contactless universal payment cards by the end of 2007 (excluding contactless public transportation cards) and that number quickly grew to over 250 million at the end of 2009. Barclaycard demonstrated the possibility of loading additional services on EMV cards in 2007, when they introduced a card that combined the Oyster card for London public transport (Kountz and Laszlo, 2007; Hancke, 2008) with a debit/credit card and the Visa *payWave* technology. However, despite the ongoing evolution of payment cards, earlier technologies' legacies are slow to disappear. Thus, current contactless cards still include magnetic strips and microprocessors that work on contact.

The momentous nature of these changes and the considerable excitement within the trade literature has not yet been matched within the academic arena [with the notable exception of Wang's (2008) brief examination of consumer behaviour in Taiwan]. Our study is designed to fill part of this void by looking at the intentions of respondents to adopt this technology in the near future. We do this through empirical testing of the technology acceptance model (TAM) of Davis (1989) and Davis et al. (1989) via ordered Logit regressions. To the best of our knowledge, this is both the first work addressing consumer preferences to both existing debit cards and to innovative proximity-type payment methods in Central and Eastern Europe and also one that is based on a large sample. By investigating the plans of potential customers, we believe that the results from this study will be of interest not only to academics, but also to marketers seeking to understand the potential take-up within target markets.

In the remainder of the paper, we first discuss the context and development of the Polish banking system before examining the technical details of contactless card technology in Section 3. We then briefly outline the TAM framework, hypothesise possible relationships in the data and explicate our empirical methodology. Section 5 discusses the data in more detail, including exploration of the summary statistics before we discuss the results. Finally, we analyse the theoretical and practical implications and present our concluding remarks.

2 The Polish banking context

Prior to the collapse of the socialist command economy in 1989, Polish banking offered only a limited range of products and services. The development of the banking system was particularly hindered by an outdated telecommunication network, which prevented the implementation of electronic advances and ensured that most transactions remained paper-based. Once the economy shifted to market conditions in the 1990s, the banks were forced to restructure and change their orientation to customers. Further stimulus was added with the privatisation process, which began in 1993 and the relaxation of restrictions on foreign ownership of Polish banks in 1998 (Bohl et al., 2006). Since then, the banking sector has changed radically, as the proportion of foreign ownership has shifted from zero to reach 60.5% in 2006 (National Bank of Poland, 2007). Concurrently, between 1995 and 2008, total assets within the sector increased from 149 billion PLN (61.6 billion USD) to 1,042 billion PLN (358.5 billion USD) (National Bank of Poland, 2007, 2009). With the move to widespread foreign investment came international banking expertise and integration with global technological standards (Walker, 1996).

ATM technology was first introduced in the UK in 1967 (Bàtiz-Lazo and Wood, 2002) but it was not until 23 years later that machines were installed in Poland primarily to cater for the needs of tourists. Similarly, the legal infrastructure for a national system for payment cards was created with the Decree of the President of the National Bank of Poland on 11 December 1992, which detailed the forms and procedures for monetary settlements through banks. This occurred over 20 years after magnetic stripe technology had been introduced in the USA [Frazer, (1985), p.267]. However, initial take-up of payment cards was slow: it was not until the late 1990s that the retail banks started widely issuing debit cards, with credit cards following even later. Over recent years, growth in these instruments has been explosive. According to data from the National Bank of Poland (2010b), the total number of payment cards in use in Poland at the end of 2009 was 33.2 million, of which 22.0 million were debit cards. 24.2% of these cards used EMV technology, with the remainder only utilising magnetic strips. The increase in the use of ATMs has been equally dramatic – with withdrawals rising from 7.5 billion PLN in 1998 to 245.1 billion in 2009 (National Bank of Poland, 2010a).

Table 1 Diffusion of payment cards and banking services in Poland and the EU

	Poland					*European Union (27 countries)*
	2005	*2006*	*2007*	*2008*	*2009*	*2009*
Bank accounts (number of current accounts per 100 inhabitants)	61.95	67.47	75.72	89.60	92.60	126.06
Payment cards (number of cards with a payment function issued per 100 inhabitants); including:	53.38	62.54	69.51	79.42	87.06	145.07
Debit cards	40.27	44.43	47.89	53.66	57.62	96.33
Other cards*	13.11	18.11	21.62	25.76	29.44	48.74
Number of card payments per capita (total for the period)	6.92	9.28	12.11	15.13	18.45	62.98
Number of payment transactions per card (total for the period)	12.97	14.84	17.43	19.05	21.19	43.41
Number of POS terminals located (per million inhabitants)	4,348.00	4,628.00	4,895.84	5,570.84	6,044.04	17,096.90
Value of card payment transactions as a ratio to GDP (total for the period)	3.31%	3.98%	4.67%	5.32%	5.77%	13.85%

Notes: The data has been taken from the statistical data warehouse of the European Central Bank.
*The category labelled 'other cards' includes, among others, credit and delayed debit cards, as well as other hybrid forms of payment cards.

Despite this rapid growth in payment cards, Poland remains a country where cash transactions still dominate. In 2005, 98% of payments relating to the running of Polish households were made in cash – which compares to figures of 93% for Spain and Italy, 72% for the UK and 70% for France (National Bank of Poland, 2008). Some of the reasons for the continued widespread use of cash in Poland can be discerned from Table 1, which juxtaposes statistical data for Poland with that of the European Union. A key difference is that Poland still lags well behind the European average in the number of bank accounts per head. And, as regards infrastructure, there are still considerably less retail outlets that possess POS terminals where payment cards may be used. Nevertheless, it is clear that Poland is catching up – the period 2005–2009 witnessed a significant growth in all of the considered parameters. POS terminals grew by almost 40%, cards per capita increased by over 60%, while number of card transactions per capita rose by over 250%.

This mirrors the adoption of other financial technologies. PC-banking was introduced in Poland in 1992, some eight years after it had been established in the USA (Grzywacz, 2004). From this late start it swiftly gathered momentum, with over 100,000 installations by 2004 (Polish Bank Association, 2004). Internet banking services arrived in 1998 (Polish Bank Association, 2006), a lag of three years from the USA and has continued to develop [Kisiel, (2007), pp.214–218; Polasik, (2007), pp.170–173]. Recent data indicates some 8.4 million users in 2009 (Polish Bank Association, 2010) reflecting the widespread investment in transaction security and increased internet use. Statistics published by Eurostat (2010) reveal that 63% of households had internet access, a marked increase from the 11% recorded in 2002. What is apparent from the above data is that adoption of financial payment innovations may have been late but once available, enthusiastically received. However, penetration rates are unlikely to reach those of some West European states due to lingering structural differences. There is a relatively high level of unbanked individuals in Poland (Maison, 2010), a cultural element to payment habits [Górka, (2009), pp.73–80] and an informal economy estimated at about 28% of GDP (Schneider, 2002). For these reasons cash remains an important medium for many transactions.

The development of internet shopping in Poland since 2004 has been most dramatic of all. Nielsen (2010) places Poland third in the European region (behind Norway and the UK) in terms of online consumers who plan to purchase products or services via the internet. This again shows that Poles are interested in innovation when it brings tangible advantages and cost benefits. Yet such transactions have a particularly Polish dimension with a significant number of transactions carried out via online auctions and payment made through either cash-on-delivery or bank transfer. Credit/debit card payments and the use of virtual payment services such as PayPal is low [Polasik and Maciejewski, (2009), pp.89–93].

The history of contactless technology in Poland begins in December 2007 when Bank Zachodni WBK S.A. issued the pre-paid Maestro *PayPass*. This card not only introduced the contactless system but was also the first form of contactless electronic money in Poland. In 2008, the same bank made further inroads into contactless technology, issuing the MasterCard *PayPass* credit card and the Visa *payWave* debit card so that by the end of 2008 there were 20,000 contactless cards in use. This ran alongside the establishment of 800 contactless terminal outlets, primarily in large metropolitan areas [Polasik et al., (2009), pp.35–37]. In 2009, five further retail banks joined the contactless bandwagon, leading to 321,000 cards being issued by December 2009, of which 197,000 were MasterCard *PayPass* and 124,000 Visa *payWave*. Over the same months, accepting retailers leapt to 6,000, including a national chain of convenience stores, by the end of 2010.

The expansion of contactless cards in Poland also has a specific flavour due to the country's relatively late adoption of EMV card technology. Until 2010, PKO Bank Polski, Poland's largest bank, was reliant upon pre-EMV magnetic stripes for its debit cards. By the end of 2011 it will have replaced its 6.5 million debit cards in circulation with EMV and at the same time used the opportunity to include Visa *payWave* contactless technology (Datamonitor, 2010). Similarly, Visa is pushing increased use of card payments including both their use for household bills and e-commerce, and simultaneously the development of a wider network of POS terminals across the country, in particular in those small and medium-sized retailers in smaller towns and rural areas that have hitherto been resistant to card acceptance (Visa, 2010b). Visa hopes to double the acceptance network to 400,000 terminals by 2015 and all will be equipped to the latest standards, including RFID (Visa, 2010a; Kiwior, 2010). The RFID component is also finding supplementary benefits: from June 2010, users of contactless cards have been able to use them to purchase tickets on Warsaw's transport system (Woodward, 2010).

At this point in time, Poland along with the UK and Turkey, lead in the adoption of contactless technology in Europe. Given the forthcoming developments, it appears that the Polish market for RFID-enabled cards may become the most developed in Europe and the case will provide an illustrative example from which followers may draw important lessons.

3 Contactless cards

3.1 The technologies of contactless cards

RFID technology originated in the Second World War, when the British Royal Air Force used transponders to provide identification of individual aircraft on radar systems [Hancke, (2008), p.295]. In 1948, Harry Stockman published a seminal work which advanced the possibility of *passive* RFID tags. A series of further advances saw the technology being used for protection against theft, keyless door operation and tracking nuclear materials. In the 1980s, RFID was deployed in the automated collection of tolls on motorways, tunnels and bridges. It became even more pervasive in the following decade, as a range of High Street stores used the system for tagging goods. Nowadays, RFID technology can be seen in logistics, public transport, security systems and in the electronic payments market [Rieback et al., 2006; Hancke, (2008), p.296; Lee et al., 2008; Roh et al., (2009), p.360].

A RFID system comprises three components: a tag, a reader and data-processor. The tag itself incorporates a microprocessor chip and an antenna, which allows it to send information to the reader. Passive RFID tags use the radio waves from the reader to generate power for the chip to emit its signal (Wu et al., 2006). As was indicated in the paragraph above, the technology can be used in a variety of ways. This is reflected in different technological parameters including the level of power demanded by the chip, the amount of memory, and the radio frequency used. This can range from larger, active, tags with battery power and substantial antennae broadcasting over longer distances to passive tags as small as 0.05×0.05 mm that only operate in close proximity to a reader (or indeed an active RFID tag), which triggers their action. Contactless cards are based around passive RFID technology [Hancke, (2008), p.296] operating at a frequency of 13.56 MHz [Gebhart et al., 2008; Hancke, (2008), p.311], which allows high speed data transmission while limiting range to 10 cm (a substantial security benefit).

When looking at the current generation of contactless cards, the legacy of earlier systems is readily visible. EMV and magnetic strip technologies are still in widespread use, with a substantial infrastructure supporting their use, and all of these are retained on current European contactless payment cards, as shown in the example in Figure 1 (Of course, the USA, which refused to adopt the EMV standard, retains only two technologies). RFID is not restricted to cards alone – and where it has been embedded in other devices such as watches, mini-cards, key fobs or even stickers – EMV and magnetic strips are absent (Smart Card Alliance, 2006). This also occurs where the cards are not required to conform to existing infrastructures, such as the London underground oyster card or some of the local payment systems in Asia.

Figure 1 The first contactless payment card issued in Poland: obverse and reverse (see online version for colours)

Note: This figure is reproduced with the permission of Bank Zachodni WBK SA.

There are many communication standards in force. However, many of these are a resolutely local or have only limited application (e.g., public transport). The main thrust of development in the area of universal contactless payments has come through the main card organisations American Express, MasterCard and Visa. In 2005, MasterCard International and Visa International entered an agreement to use a common radio communication protocol – ISO 14443 A/B – based on RFID (Rae, 2005), which has since been used also by American Express and partly by the Japan Credit Bureau (JCB). Adoption of a standard both lowered the product costs for the banks and facilitated popularisation through the possibility of one terminal accepting a wide range of cards. It is important to stress that RFID only changes the technological interface between card and EFT POS terminal. It does not change the legal form or liabilities associated with different types of card – a credit card remains a credit card whether it operates through magnetic stripe, EMV or RFID, and the same holds for all the other myriad payment cards, be they debit, charge, prepaid or electronic wallet.

In operation, the cards have to be placed close – within a few centimetres – to the terminal reader for around half a second. The terminal will communicate the completion of the transaction by beeping and flashing four LEDs (a procedure defined within the ISO standard). The total time for a transaction will vary according to whether the terminal is offline (unconnected to an authorisation server) or online. For online terminals, the transaction time will also be dependent on the type of communication link with the authentication point. Thus, transaction times will be a few seconds for offline terminals, and slightly longer for online. This is much quicker than other card transactions, primarily because there is no requirement for the customer to use a system such as PIN or signature.

The flipside of the absence of customer verification is that it raises fears among potential users of unauthorised transactions taking place without their knowledge or consent. There have been scare stories about the possibility of unscrupulous retailers making additional charges and thieves using portable readers to defraud people in public places. However, there are many reasons why advocates consider contactless cards as both speedy and less at risk than cash. First, there are limits as to how much money can be lost in the event of the card going missing or being stolen. Each transaction is limited to 25 USD in the USA, 20 EUR for most European countries and 15 GPB for the UK (Eastwood, 2008). The limit in Poland has been established at 50 PLN, which is currently equivalent to about 18 USD. A further feature could be that after several transactions the card has to be verified by a PIN code. Additionally, bank guarantees and card insurance ensures that the costs of multiple withdrawals by thieves would not be borne by the consumer. The maximum distance from which a card can be read is 10 cm (Gebhart et al., 2008) – in practise it may be significantly less – which makes casual thievery difficult. The final, and probably most important, is that the card does not work like an electronic wallet – the holder of the POS terminal has to sign a contract with the acquirer, which removes the anonymity of potential offenders. Clearing is also delayed so that, with the small value of transactions and the application of fraud detection systems (Quah and Sriganesh, 2008), organised theft becomes economically unviable.

3.2 The benefits for consumers, retailers and banks

There are three distinct groups that could potentially benefit from the widespread introduction of contactless card payment systems: consumers, retailers and banks. For consumers, the card is suited to low-value transactions, potentially obviating the need to carry (and constantly replenish) cash (Olsen, 2008). The system also promises the possibility of allowing users to analyse and control their spending, in a way that would be excessively onerous from re-constructing the multitude of cash transactions. The latest systems are almost instantaneous since, unlike traditional[1] debit cards, there is no need to input a PIN nor to pass the card to a vendor. Keeping the card to yourself has other advantages, such as the lower probability of the card being 'skimmed'. Ultimately, as the technology becomes accepted, the mechanism may be deployed on a range of other everyday times, such as key fobs, mobile phones and watches. Then, or so the promise goes, we shall be freed from the need to even carry cards.

For goods and service providers, some of the advantages are the same as for consumers. As transactions take place much faster, this leads to less queuing, thereby helping improve customer satisfaction – not only for traditional retailers but for a vast range of businesses including mass-event organisers, transport companies and fast-food chains (Olsen, 2008). Shorter queues also contribute to greater throughput and better staff productivity – Borzekowski and Kiser (2008, p.900) estimate that the reduced checkout time due to the use of contactless cards could result in cost savings of \$0.03 per transaction (see also the empirical study by Polasik et al., 2011a). The shift from cash to cashless has a similar, albeit more pronounced effect to the benefit enjoyed by consumers. Retailers will have the significant burden of cash storage, transportation and security reduced [see Garcia-Schwartz et al. (2006): Table 2 for an analysis of these costs]. There is a clear question that lies over the development of a sufficiently widespread network of outlets using this technology. As consumer take-up increases, those who fail to offer this technology will undoubtedly be penalised as customers migrate elsewhere. On the flipside, there are costs attached – most notably the purchase of a card reader that can be added to an existing payment terminal.

For banks, or other card issuers, the benefits are more direct. Smaller transactions, hitherto overwhelmingly settled in cash, can now come within the ambit of the banking system with consequent transaction charges (paid by the merchant). Since low-value transactions dominate the volume of cash turnover in the retail trade [see Eastwood, (2008), p.78] and cash is 'the most popular payment vehicle' [Clark, (2005), p.35], this may prove a substantial gain. Indeed, for banks, cash itself carries significant overheads, particularly in ATM maintenance, as well as the cost of labour required to deal with cash withdrawals and retailers' deposits (Guibourg and Segendorff, 2007: Table 2). The cost of cash is further diminished as consumers move to prepaid contactless cards, which also offer the opportunity to extend banking services to those who currently do not benefit from then. Although this will primarily be a means of drawing younger and younger customers in, there is also the possibility of reaching many seniors. And the marketing opportunities do not end there; the issuance of a new card offers the chance of cross-selling other banking products.

3.3 Further issues

The idea of the cashless society has excited much interest (see, for example Worthington, 1995; Garcia-Schwartz et al., 2006). Contactless cards finally represent competition for the last bastion of cash: low-value transactions. This is of possible benefit for government for three reasons: it reduces the macro-economic cost of payments; potentially eliminates much of the black and grey economy; and it brings more economic transactions under government surveillance. The cost reduction primarily arises from the three aforementioned aspects of payment markets and the lower cost of 'minting' electronic money compared to physical specie [Brits and Winder, (2005) pp.11–12; Quaden, 2005; Gresvik and Haare, 2009). However, the main impetus from governments towards electronification of monetary transactions comes from the drive to combat the black economy and money-laundering [Brits and Winder, (2005), pp.32–33]. The size of the black economy was estimated at 28% of GDP in Poland, 9% in the USA, 13% in the UK and 16% in Germany [Schneider, (2005), pp.610–611] and governments are understandably keen to bring this within the purview of taxation and regulation.

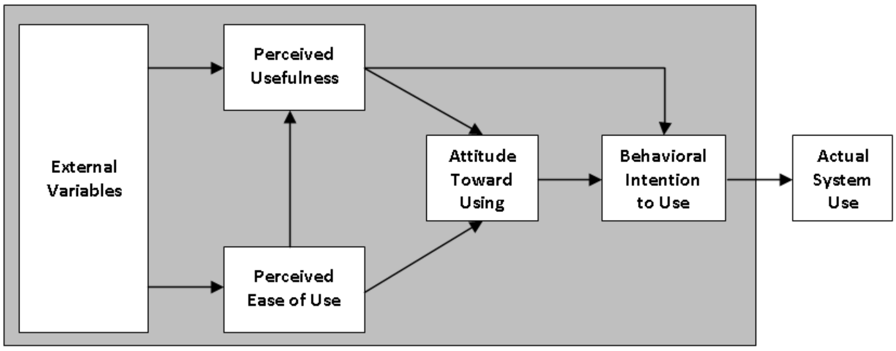
The electronic payment instruments, unlike cash, are not anonymous, reflecting a conscious intention on the part of the authorities. Governments depict this as part of a necessary crackdown on money-laundering (Buchanan, 2004; Choo, 2009), but at the same time the possibility of extending government invigilation across a greater swathe of society has provoked the possibility of further invasion of personal privacy [Reischmann and Miller, (2007), pp.14–23]. However, in places in Western Europe where electronic transactions are part of everyday life, citizens seem to be dismissive of such concerns. For example, in Holland where card payments are widespread, only 1%–2% of people declare that they want to retain anonymity over their payments (Jonker, 2007). In post-communist Eastern Europe, where memories remain of intrusive state surveillance and the informal economy plays a larger part, people attach a greater importance to the issue of anonymity (in Poland, 43%: Polasik and Maciejewski, 2009). However, contactless prepaid cards can remain anonymous (similar to most prepaid cards currently in use) and it is likely that such an option will need to be retained to achieve wide acceptance in that part of the world.

Contactless cards are probably not the end of the story. Advocates of the technology suggest that the idea of the card itself may become obsolete as further developments of the RFID technology, such as near field communication (NFC), become subsumed within other handheld devices – most notably mobile phones[2]. Currently, however, this technology is still inchoate outside Japan, where it has already been implemented on a large scale (Bradford and Hayashi, 2007). This integration of mobile telephony and NFC technology appears to be the most likely line of development of proximity-type retail payments in the future (Eastwood, 2008).

4 Theoretical and empirical models

Our study uses the TAM developed by Davis (1989; Davis et al., 1989) that explicates the diffusion of innovations. The model is perhaps the most widely cited framework for examining technological adoption and has been widely tested across a range of innovations (Al-Gahtani, 2001; Mathieson, 1991; Pikkarainen et al., 2004). It has been of particular interest to scholars examining developments in banking, including mobile payments (Gu et al., 2009; Shin, 2009; Schierz et al., 2010), internet banking (Pikkarainen et al., 2004; Gerrard et al., 2006), mobile credit card usage (Amin, 2007) and online trading (Lee, 2009). In essence, the model provides a framework that connects Perceived Usefulness and Perceived Ease of Use of a product to Behavioural Intention to Use and, ultimately, Actual Use, as shown in Figure 2. However, as Agarwal and Prasad (1999) argue, for survey-based research it is more appropriate to consider intentions, rather than usage, as they are contemporaneous with beliefs as to usefulness and ease of use. Also, at this stage, the take up of this technology is low, so the task of modelling actual usage becomes impractical. Consumer intentions are important in determining marketing strategy, particularly in targeting groups that might be seen as potential early adopters and identifying others that may be resistant to innovation. Further, it has been well established in prior literature that socio-demographic variables are important in determining intentions towards technological adoption [see, for example, Venkatesh et al. (2000), Morris and Venkatesh (2000), Stavins (2001), Im et al. (2003)].

Figure 2 The TAM



Source: Adapted from Davis et al. (1989)

In the light of the foregoing discussion, we arrive at three testable hypotheses:

Hypothesis 1 Perceived usefulness determines behavioural intention to use contactless cards.

Hypothesis 2 Perceived ease of use affects behavioural intention to use contactless cards.

Hypothesis 3 Demographic characteristics differentiate respondents' behavioural intention to use traditional debit and contactless cards.

The variables used to explore the linkages are detailed in the following section.

Our dependent variable in this study is *Behavioural_Intention_to_Use*, measured on a Likert scale, ranging from 1 (denoting ‘highly unlikely to use’) to 5 (the opposite end of the intentional spectrum). Because the variable is both ordinal and discrete, simple OLS is inappropriate in this context and thus we use the ordered logit model (described in great detail in Borooah, 2002). However, for the sake of completeness, we did carry out an OLS estimation and found that the main conclusions are unchanged. In our study, we consider a latent variable LV which is a linear combination of our independent variables and an error term:

$$\begin{aligned} LV_i &= \beta_1 Perceived\_Ease\_of\_Use_i + \beta_2 Perceived\_Usefulness_i \\ &\quad + \sum\nolimits_{j=1}^{6} \beta_{2+j} Demographic\_Variable_i^j + \varepsilon_i = Z_i + \varepsilon_i \end{aligned} \tag{1}$$

where i is an index for the respondent, the first two variables are TAM constructs further defined in Table 3 and the last six variables measure the demographic characteristics of the respondent. In some of the specifications of latent regressions selected βs can be restricted to zero. The equation does not include an intercept term, as it later becomes absorbed into the thresholds [Borooah, (2002), p.10]. We are assuming that the latent error ε_i is logistically distributed. As we show below, respondents are categorised into five levels of intention, based upon the value of the latent variable LV:

$$Behavioral\_Intention\_to\_Use_i = \begin{cases} 1 & \text{if} \quad LV_i \le \gamma_1 \\ 2 & \text{if} \quad \gamma_1 < LV_i \le \gamma_2 \\ \vdots & \\ 5 & \text{if} \quad \gamma_4 < LV_i \end{cases} \tag{2}$$

where γs are threshold values estimated jointly with βs. From this, it follows that the probabilities of observing a given value of *Behavioural_Intention_to_Use*$_i$ are:

$$\Pr\left(Behavioral\_Intention\_to\_Use_i = 1\right) = 1/\left[1 + \exp\left(Z_i - \gamma_1\right)\right] \tag{3}$$

$$\begin{aligned} \Pr\left(Behavioral\_Intention\_to\_Use = 2\right) &= 1/\left[1 + \exp\left(Z_i - \gamma_2\right)\right] \\ &\quad - 1/\left[1 + \exp\left(Z_i - \gamma_1\right)\right] \end{aligned} \tag{4}$$

$$\vdots$$

$$\Pr\left(Behavioral\_Intention\_to\_Use_i = 5\right) = 1 - 1/\left[1 + \exp\left(Z_i - \gamma_4\right)\right] \tag{5}$$

We have N respondents in our sample and each is considered a single draw from a multinomial distribution with the possibility of one of five outcomes. Thus, the sample can be subdivided based on these outcomes so for N_1 individuals *Behavioural_Intention_to_Use* is 1 (highly unlikely), whereas N_5 respondents declare that their use of a given technology in the future is 5 (highly likely). Given this notation, the likelihood function can be expressed as follows:

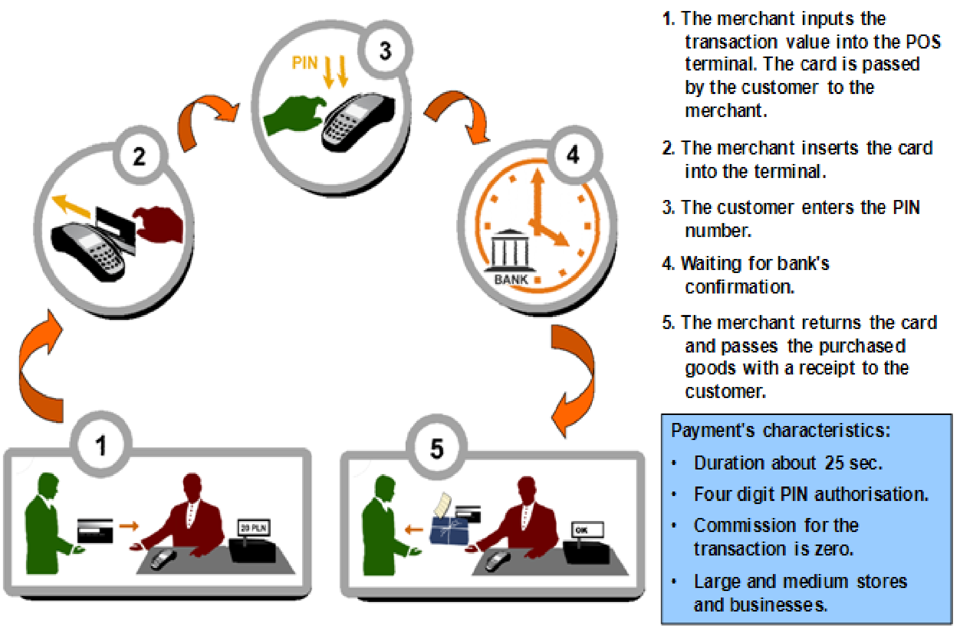
$$\begin{aligned} L &= \left[\Pr\left(Behavioral\_Intention\_to\_Use_i = 1\right)\right]^{N_1} \times \ldots \\ &\quad \times \left[\Pr\left(Behavioral\_Intention\_to\_Use_i = 5\right)\right]^{N_5} \end{aligned} \tag{6}$$

where $N = \sum_{i=1}^{5} N_i$. The values of βs and γs are estimated by maximising the log of the likelihood function above.

5 Data

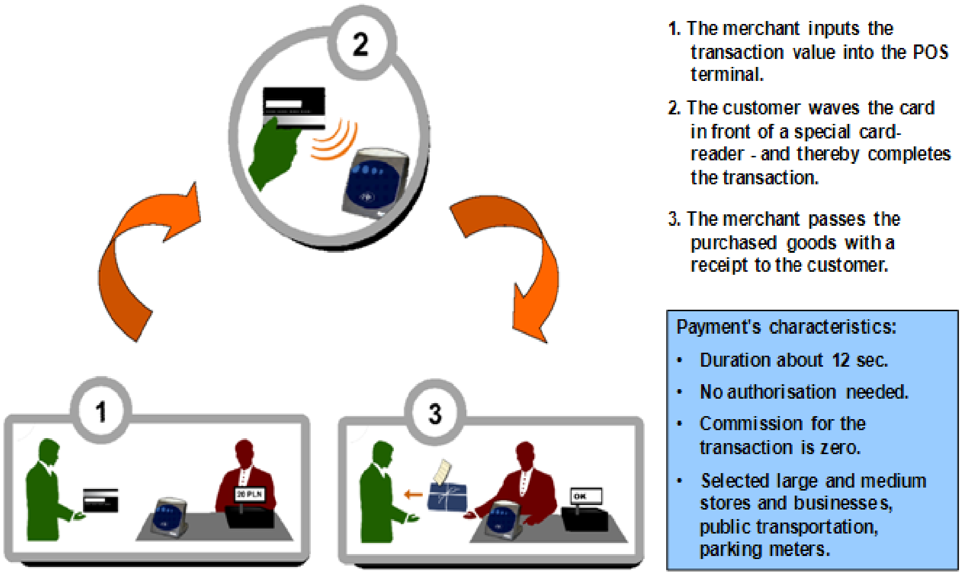
The data for this study emerged from a collaborative effort between the researchers and the National Bank of Poland. The idea for the study and the questionnaire design was developed by the former, while the Bank paid for the collection of data by independent consultants from Millward Brown SMG/KRC. The data was a random representative sample of 1010 Polish respondents aged between 15 and 75, although useable data for this particular study was restricted by people who did not offer responses to the questions of interest to us[3]. 174 canvassers carried out interviews at respondents' homes across Poland and followed computer aided personal interview (CAPI) protocols. As part of this process, interviewees were shown diagrams relating to payment processes on a laptop screen. Figure 3 and Figure 4 are examples used to illustrate the differences between different card technologies.

Figure 3 Debit card in contact technology: stages of the payment process (see online version for colours)



Note: Respondents were shown this diagram in interviews to illustrate how the technology works.

Figure 4 Contactless card: stages of the payment process (see online version for colours)



Note: Respondents were shown this diagram in interviews to illustrate how the technology works.

The interviewees were sampled from the PESEL (a personal identification number) database compiled by the Ministry of the Interior and Administration. Systematic sampling was used to draw particular respondents within pre-specified strata. The stratification took into account urbanisation, voivodeships (the 16 Polish administrative regions), gender and age. The first phase of the sample selection procedure arranged geographical representation through the localisation criterion and degree of urbanisation. Within these selected localities, the respondents were then stratified with respect to age and gender. When the study was carried out, non-responders were primarily replaced based on address. By the end of the process, the sample did not diverge from the overall population on the above criteria.

Table 2 details the definitions of variables used in this study. The first three, *Behavioural_Intention_to_Use*, *Perceived_Ease_of_Use* and *Perceived_Usefulness* are the central pillars on which the TAM framework rests. The remaining variables are demographic. As questions as to *Perceived_Ease_of_Use* and *Perceived_Usefulness* were not directly asked (nor would be particularly helpful, had they been so) we use constructs to arrive at these variables by aggregating a number of different questionnaire items, as shown in Panel A of Table 3. The responses for each of the questions regarding transaction speed, cost attractiveness, effortlessness of use and convenience of conducting transactions were generated by asking interviewees their level of agreement to a statement about the above mentioned features. Following established procedures for generating a five-point Likert scale (see Likert, 1932) respondents were asked if they strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with the statement and these responses were given values of 1 to 5 respectively. *Perceived_Ease_of_Use* averages the scores for effortlessness and convenience, while *Perceived_Usefulness* takes the mean of speed and cost.

Table 2 Variable definitions

Variable name	*Definition*	*References*
Behavioural_Intention_to_Use	Gauges respondent's self-declared likelihood of using a particular payment method within the next six months. It is measured on a five-point scale: 1 Highly unlikely to use 2 Unlikely to use 3 Neither unlikely nor likely to use 4 Likely to use 5 Highly likely to use.	Davis (1989), Davis et al. (1989), Gu et al. (2009), Muller-Seitz et al. (2009) and Kim et al. (2010)
Perceived_Ease_of_Use	Is a construct averaging two questionnaire items, namely 'effortlessness of use' and 'convenience of conducting transactions'. Each item was measured on a five-point Likert scale expressing agreement with a statement as to whether the contactless cards possess these particular characteristics. The scale was as follows: 1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree.	Davis (1989), Davis et al. (1989), Amin (2007), Shin (2009) and Crotty (2009)
Perceived_Usefulness	Is a construct which averages the two following items: 'transaction speed' and 'cost attractiveness', each of which was measured in the same way as 'effortlessness of use' and 'convenience of conducting transactions'.	Davis (1989), Davis et al. (1989), Jonker (2007), Klee (2008) and Schuh and Stavins (2010)
Area_of_Residence	Denotes the natural logarithm of the population of the city/town/village in which the respondent resides (in thousands of people).	Gan et al. (2006) and Klee (2008)
Gender	Takes a value of one if the respondent is a male and zero otherwise.	Carow and Staten (1999), Borzekowski and Kiser (2008) and Shin (2009)
Education	Measures the number of years in formal education. It has been derived from the highest educational attainment.	Carow and Staten (1999), Klee (2008), Borzekowski and Kiser (2008) and Von Kalckreuth et al. (2009)
Single	Takes the value of one for anyone who is not married and zero otherwise.	Borzekowski and Kiser (2008), Gu et al. (2009) and Schuh and Stavins (2010)
Income	Records the household income (in thousands of PLN) divided by the number of household members.	Borzekowski and Kiser (2008) and Schuh and Stavins (2010)
Senior	Takes the value of one for respondents above 65 years of age and zero otherwise.	Carow and Staten (1999), Schuh and Stavins (2010) and Kim et al. (2010)

Table 3 Appropriateness of empirical measures

Panel A: Reliability analysis			
Construct	*Item*	*Cronbach's Alpha*	
		Traditional debit cards	*Contactless cards*
Perceived_Usefulness	Transaction speed	0.8180	0.8723
	Cost attractiveness		
Perceived_Ease_of_Use	Effortlessness of use	0.8913	0.9094
	Convenience of conducting transactions		
Panel B: Confirmatory factor analysis			
Payment method	*Chi-square*	*p-value*	*RMSEA*
Traditional debit cards	1.8774	0.1706	0.0356
Contactless cards	0.4243	0.5148	0.0000

Notes: The questionnaire items were measured on a five-point Likert scale, where the lowest assessment of a particular characteristic was recorded as one and the most positive responses recorded as five. Panel A of the table reports Cronbach's alphas for the constructs used in our empirical specifications. Panel B shows results of confirmatory factor analysis, which assumes an existence of two correlated common factors. Items 'transaction speed' and 'cost attractiveness' are assumed to load only on one factor, while 'effortlessness of use' and 'convenience of conducting transactions' load only on the second remaining factor. The Chi-square statistics and its corresponding p-value are for the null hypothesis that this presupposed model is an acceptable fit for the observed data. RMSEA stands for root mean square error of approximation.

We test these constructs for reliability using Cronbach's alpha (see Cronbach, 1951) and confirmatory factor analysis[4]. Panel A of Table 3 shows that the estimated values of the Cronbach's alpha coefficients substantially exceed the lower threshold of 0.6 showing that the internal consistency of the constructs can be deemed acceptable (Churchill, 1979; Hair et al., 1998). Panel B reports on the confirmatory factor analysis where we assume the existence of two correlated common factors: the components of *Perceived_Usefulness* load on one factor and those that make up *Perceived_Ease_of_Use* load on the second. The chi-square test does not reject the null hypothesis that the structure is valid and the values of root mean square of approximation (RMSEA) are within the acceptable range. Overall, these tests indicate that the model is an adequate reflection of the underlying data (Long, 1994).

We further probe for the discriminant validity of *Perceived_Usefulness* and *Perceived_Ease_of_Use*, following the prescriptions of Fornell and Larcker (1981). We calculated the square root of average variance extracted (AVE) for the two constructs and compared them to the correlation between them. The results confirm that discriminant validity seems to be satisfactory in the cases of both debit and contactless cards.[5]

Summary statistics for our dataset are presented in Table 4. There are two sub-samples of different sizes, which is a by-product of removing entries with incomplete responses. Examination of the two panels reveals that both are representative of the population as a whole, and the characteristics of an average respondent similar, with the exception of the TAM variables. Here it is apparent that interviewees, on average, indicated that they were more likely to use contact rather than contactless technology in the future, as they saw it as both easier to use and more useful. An average respondent was equally likely to be male or female and had over 12 years of formal education. The figure for *single* initially appears high, but this variable differentiated solely on marital status, thus including cohabitating couples. The average size of the locality in which respondents lived was around exp(3.6) ≈ 36.6 thousand people, and the mean household income per head was just over 1,000 PLN. Finally, our table shows that roughly one in seventeen was over the age of 65. The median figures allow us to generate a profile of a representative respondent and her/his preferences.

Table 4 Summary statistics

Variables	*Mean*	*Median*	*Standard deviation*	*t-statistic*	*p-value*
			Panel A: Traditional debit cards (N = 694)		
Perceived_Ease_of_Use	3.6780	4.0000	0.9299	7.0394	0.0000
Perceived_Usefulness	3.6174	4.0000	0.9106	6.8939	0.0000
Area_of_Residence	3.6133	2.9444	1.8738	3.6375	0.0003
Gender	0.4971	0.0000	0.5004	2.3238	0.0205
Education	12.4546	12.5000	2.4505	5.0969	0.0000
Single	0.4669	0.0000	0.4993	–0.4282	0.6687
Income	1.0295	0.7000	1.1110	2.9759	0.0031
Senior	0.0591	0.0000	0.2359	–4.2422	0.0000
Behavioural_Intention_to_Use	2.6916	2.0000	1.4584	–	–
			Panel B: Contactless card (N = 581)		
Perceived_Ease_of_Use	3.5336	3.5000	1.0365	3.9026	0.0001
Perceived_Usefulness	3.4905	3.5000	1.0122	4.6027	0.0000
Area_of_Residence	3.5757	2.9444	1.8657	2.0449	0.0423
Gender	0.5043	1.0000	0.5004	0.5293	0.5973
Education	12.3313	12.5000	2.4350	1.6922	0.0926
Single	0.4819	0.0000	0.5001	2.9284	0.0039
Income	1.0183	0.7000	1.0926	0.9602	0.0423
Senior	0.0602	0.0000	0.2381	–2.1219	0.0348
Behavioural_Intention_to_Use	2.1394	2.0000	1.2288	–	–

Notes: The sample sizes are $N = 694$ for Panel A and $N = 581$ for Panel B. The difference arises from the number of usable responses across the relevant questions. Each sample is divided according to the positive or negative expressions of Behavioural_Intention_to_Use as measured on a five-point Likert scale. Within positive, we include respondents who declare that they are likely or highly likely to use a given technology, whereas negatives incorporate those expressing unlikely and highly unlikely intentions. Under the null hypothesis that the averages of a given variable are equal within these two groups, the t-statistic follows a student's t distribution. The degrees of freedom have been calculated using the Welch-Satterthwaite equation (Welch, 1947; Satterthwaite, 1946). The p-value is the probability of observing a more extreme t-statistic than the one that is reported in the table, assuming validity of the null hypothesis.

Each of the samples was divided in two depending upon the value of the variable *Behavioural_Intention_to_Use*. The first group paired responses of 1 and 2, the second included those who replied that that they were likely or very likely to use a given technology, while the undecided were eliminated from the testing. The *t*-tests for unequal sample sizes and variances are given in the table and the degrees of freedom have been calculated using the Welch-Satterthwaite equation (Welch, 1947; Satterthwaite, 1946). The corresponding *p*-values are reported in the last column. The *t*-statistics give us a first glimpse of what we might expect from a more elaborate empirical model and they are illuminating. Among all of the variables, only *Gender* is insignificant for contactless cards, and marital status for traditional debit cards.

Table 5 Modelling the behavioural intention to use: ordered logit estimates

Panel A: Determinants of Behavioural_Intention_to_Use – traditional debit cards					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Perceived_Ease_of_Use	0.6287*** *(0.0804)*		0.5463*** *(0.0836)*		0.5530*** *(0.0838)*
Perceived_Usefulness		0.6165*** *(0.0816)*		0.5726*** *(0.0859)*	0.3473** *(0.1568)*
Area_of_Residence			0.1703*** *(0.0382)*	0.1802*** *(0.0384)*	0.1778*** *(0.0384)*
Gender			0.2956** *(0.1395)*	0.3191** *(0.1394)*	0.3057** *(0.1397)*
Education			0.1230*** *(0.0290)*	0.1335*** *(0.0289)*	0.1278*** *(0.0291)*
Single			–0.2287 *(0.1425)*	–0.2267 *(0.1423)*	–0.2338 *(0.1425)*
Income			0.1056* *(0.0623)*	0.0967 *(0.0625)*	0.0985 *(0.0625)*
Senior			–1.1568*** *(0.3486)*	–1.1383*** *(0.3504)*	–1.1177*** *(0.3506)*
$\gamma 1$	1.4057*** *(0.2989)*	1.3267*** *(0.2985)*	3.2819*** *(0.4701)*	3.5112*** *(0.4886)*	3.3850*** *(0.4748)*
$\gamma 2$	2.3842*** *(0.3060)*	2.3010*** *(0.3052)*	4.3384*** *(0.4807)*	4.5707*** *(0.4996)*	4.4462*** *(0.4856)*
$\gamma 3$	2.8554*** *(0.3109)*	2.7712*** *(0.3102)*	4.8395*** *(0.4865)*	5.0740*** *(0.5057)*	4.9502*** *(0.4916)*
$\gamma 4$	4.2117*** *(0.3319)*	4.1236*** *(0.3309)*	6.2644*** *(0.5083)*	6.5008*** *(0.5275)*	6.3815*** *(0.5137)*
LR statistic	64.6742	60.1512	133.0175	134.9750	137.9212
Prob(LR statistic)	0.0000	0.0000	0.0000	0.0000	0.0000
Percentage of outcomes predicted correctly	32.4207	32.8530	35.7349	35.5908	36.3112

Notes: Due to high correlation between Perceived_Ease_of_Use and Perceived_Usefulness, these variables were orthoganalised in model (5) in order to avoid multicollinearity. The γ thresholds have been estimated jointly with the regression coefficients. The standard errors are reported in parentheses.
*, **, *** denote statistical significance at 10%, 5% and 1%, respectively.

Table 5 Modelling the behavioural intention to use: ordered logit estimates (continued)

Panel B: Determinants of Behavioural_Intention_to_Use – contactless cards					
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Perceived_Ease_of_Use	0.2268*** *(0.0745)*		0.1388* *(0.0789)*		0.1527* *(0.0794)*
Perceived_Usefulness		0.3321*** *(0.0781)*		0.2576*** *(0.0827)*	0.4931*** *(0.1587)*
Area_of_Residence			0.0420 *(0.0415)*	0.0369 *(0.0415)*	0.0396 *(0.0416)*
Gender			–0.0716 (0.1540)	–0.0969 *(0.1546)*	–0.1099 *(0.1548)*
Education			0.0897*** *(0.0321)*	0.0858*** *(0.0321)*	0.0868*** *(0.0321)*
Single			0.4016** *(0.1572)*	0.3993** *(0.1573)*	0.4161*** *(0.1576)*
Income			0.0531 *(0.0687)*	0.0480 *(0.0689)*	0.0457 *(0.0692)*
Senior			–0.6094* *(0.3647)*	–0.4746 *(0.3665)*	–0.5155 *(0.3688)*
γ1	0.4436 *(0.2745)*	0.7990*** *(0.2842)*	1.5612*** *(0.4919)*	1.8909*** *(0.4973)*	1.5527*** *(0.4933)*
γ2	1.5659*** *(0.2803)*	1.9347*** *(0.2924)*	2.7229*** *(0.5006)*	3.0626*** *(0.5074)*	2.7313*** *(0.5020)*
γ3	2.2771*** *(0.2886)*	2.6530*** *(0.3018)*	3.4506*** *(0.5082)*	3.7961*** *(0.5157)*	3.4676*** *(0.5097)*
γ4	3.8445*** *(0.3365)*	4.2280*** *(0.3490)*	5.0345*** *(0.5410)*	5.3867*** *(0.5486)*	5.0587*** *(0.5423)*
LR statistic	9.3867	18.5130	32.8342	39.5499	42.6118
Prob(LR statistic)	0.0022	0.0000	0.0000	0.0000	0.0000
Percentage of outcomes predicted correctly	41.3081	41.3081	41.1360	42.8571	41.8244

Notes: Due to high correlation between Perceived_Ease_of_Use and Perceived_Usefulness, these variables were orthoganalised in model (5) in order to avoid multicollinearity. The γ thresholds have been estimated jointly with the regression coefficients. The standard errors are reported in parentheses.
*, **, *** denote statistical significance at 10%, 5% and 1%, respectively.

6 Empirical results

The first point of note arising from the inspection of our Table 5 is that it adds to the body of work that affirms the efficacy of the TAM framework [see, for instance Al-Gahtani (2001), Mathieson (1991), Pikkarainen et al. (2004) and Schierz et al. (2010)]. Both *Perceived_Ease_of_Use* and *Perceived_Usefulness* are significant in all of the considered models, a finding consistent with the results of Amin (2007) for mobile credit cards and Muller-Seitz et al. (2009) for RFID technology in customer checkout and complaint handling. Accordingly, the data provides support to our first two hypotheses detailed in Section 4. It needs to be mentioned at this stage that these two variables are highly correlated, as predicted by the theoretical model in Figure 2. To avoid the issue of multicollinearity in model (5), where the two constructs are bundled together, we have performed an orthogonalisation procedure[6].

As for the demographic variables, it is education that appears to exert the strongest influence across the two technologies. In this, our study suggests that the importance of formal schooling, as described by Carow and Staten (1999) for debit and credit cards is carried across to contactless payments. This is perhaps largely to be expected, as exploratory studies [such as Parasuraman's (2000) influential paper on the technology readiness index] suggest that one of the key drivers towards the acceptance of new technology is the level of discomfort that users initially experience. Since many of the measures of discomfort appear to score consumers inability to understand new technology and its implications, we should expect, in general, those with a higher level of education to be more comfortable. Also, research suggests that more educated workers are more likely to come into contact with a variety of new technologies through their employment (see, for example, Bartel and Lichtenberg, 1987).

Carow and Staten (1999), Borzekowski and Kiser (2008, p.895, p.899) and Hoffmann et al. (2009) argue that the age of respondents negatively impacts upon the propensity to use plastic. Our results concur, with the additional finding that this is more strongly emphasised where the technology is already in widespread use. Several potentially different rationalisations can be offered for the observed 'digital generation gap'. For example, this disjuncture can be discussed both in connection to risk aversion (see Halek and Eisenhauer, 2001) and individual learning behaviour (see Jamieson and Rogers, 2000). Gender and residential differences are significant for user intentions for traditional debit cards but not for contactless. Gender difference may be explicable through disparate employment rates for men and women in Poland, with employees consequently more likely to possess both a bank account and a debit card. In 2010, employment rates for males stood at 58% and 43.5% for females (Central Statistical Office, 2010) and this disparity seems to account for statistically significant coefficients on *Gender* reported in Panel A of Table 5. However, the insignificance of the same variable in Panel B perhaps suggests that both genders are equally appraised of the potential benefits of the new technology. Similarly, the likely explanation for the differences in significance of the *Area_of_Residence* variable may lie with the currently relatively poor infrastructure supporting plastic transactions in rural areas. This, of course, does not preclude respondents from seeing the advantages inherent in contactless cards.

One of the more interesting results is that for *Single*, where it is positively influential, and significant, for contactless cards. By contrast, for traditional debit it is negatively so and close to being significant at the 10% level. In view of our results, singles can be viewed as technological early-adopters, according to the terminology of Rogers (1962). Initially when a new product is launched, 'early adopters' are quick to engage, before being followed by the majority. But the newness of the product is part of the appeal for these technological pioneers – once it is so diffuse as to become part of everyday life, their interest wanes. The impact of income is, in general, positive but not statistically robust. Overall, then, these results lend some support to our third hypothesis that demographic characteristics differentiate consumers' intentions.

7 Theoretical and practical implications

One of the more interesting theoretical conclusions is that the TAM model (Davis, 1989; Davis et al., 1989) continues to remain relevant across an ever-changing terrain of innovation. It is a mark of the solidity of the original construction that it endures the test of time. In addition, the two constructs used in this study, *Perceived_Ease_of_Use* and *Perceived_Usefulness* appear to capture well the key theoretical components of the model. However, such psychological categories are unlikely to fully account for the entirety of human intention to adopt new technologies and future research may usefully deploy additional control variables. Similarly, as the technology becomes more widespread, later studies may endeavour to model actual usage as opposed to intentions.

Our results show that intention to use payment technologies differs across payment systems. Part of this comes from the ready visibility of traditional debit cards and the relative niche marketing of contactless technology to potential consumers. Many will be uncertain about the possible benefits of this new form of payment – hitherto advertising has concentrated on the ease of use of the new cards and perceived usefulness has so far only received little coverage in marketing communications. The benefits to the consumer, such as shorter queuing, the removal of the necessity of carrying cash and the possibilities of paying for public transportation and services at mass events have not been emphasised enough. We suggest that future marketing efforts focus on this area.

The study shows that there is a marked difference between the drivers for intentions between contact-based versus contactless technologies. This has important repercussions for the future marketing and promotion of the latter. Since the demographics of the target groups differ, marketers will need to seek alternative strategies to those in place for existing debit cards. At this stage of diffusion of contactless cards we might suggest that we are still on the lower foothills of the S-curve of adoption (Kuznets, 1930). In particular, it appears that the early adopters (Rogers, 1962) are likely to be well-educated singles. As Hooley and Saunders (1993) note, their 'lifestage' demographic segmentation identifies these consumers as having few financial burdens, recreation-oriented with a focus on entertainments outside the home. Successful marketing communication strategies are likely to be ones that emphasise these themes.

Rogers' (1962) model of the diffusion of technology has further relevance to the findings of this study. As the level of adoption moves though the stages of 'early majority' and 'late majority', the target group will also change. As our research indirectly shows, the willingness to accept traditional debit and contactless cards differs across demographics. With growing maturity of the innovation, marketing effort will also need to evolve to take account of the shifting audience and broaden its appeal beyond the initial group of early adopters. Our results for debit card intentions perhaps suggest that once a technology becomes ubiquitous and an integral part of everyday life, then they appear mundane to those most interested in newer technologies.

What is also evident from our estimates is that consumers who perceive a technology as being easy to use are likely to be more positively inclined towards it. This has important ramifications for the design of banking products and services, particularly in these turbulent times. Many scholars have indentified the complexity of financial innovations as one of the root causes of the recent financial crisis (see, for example, Crotty, 2009; Issing, 2009; Mackenzie, 2011). It appears probable that consumers will be increasingly wary of financial developments that they do not fully understand.

Within the literature on payment innovations, there is consensus on the importance of network size, whether labelled as the 'network externality' (Katz and Shapiro, 1985), the 'network effect' (Liebowitz and Margolis, 1994), or 'positive size externality' (Economides, 1993). As payment systems are typical examples of two-sided markets (Rochet and Tirole, 2003), the existence of a critical mass of both customers and retailers is thus one of the factors promoting further adoption of innovations. Within Poland, as we have seen in Section 2, the number of cards in circulation has risen dramatically over recent times and continues to increase. As the market becomes flooded with cards there is increasing pressure from consumers, driving retailers to invest in new contactless readers, costing between $100 and $150 each (Wolfe, 2010). Consequently, Datamonitor (2010) has predicted a sharp rise in the number of terminals. With both consumers and merchants holding the necessary tools, the endemic 'chicken-and-egg' problem may be solved and this suggests that the tipping point might be close. Should the Polish experiment prove successful, it will serve as a model for other countries. However, it does appear that for consumers to shift from mere possession of cards to their actual use, there must be a strong marketing campaign (Wolfe, 2010).

Such a campaign may be well received by consumers. Recent research by Barclays Bank (2010) has shown that consumers are increasingly impatient with queues. Their study suggest that two fifths of people will refuse to queue for more than two minutes, while two thirds will abandon purchases rather than face an extended wait. Our empirical model included transaction speed as one of the components of *Perceived_Usefulness,* which proved to significantly affect *Behavioural_Intention_To_Use.* It needs to be noted that in Europe, contactless cards are being issued to customers at a similar cost to traditional debit cards. In the light of our results, this is likely to aid proliferation of this technology.

Other research has shown that contactless technology has been widely used in a range of business contexts and has become generally accepted by consumers in applications such as public transportation networks. It is also clear that mobile phone suppliers and operators are gearing up for a further push on NFC (a shorter range subset of RFID technology) (see Fischer, 2009, for example). This opens up both opportunities and threats for banks interested in developing contactless cards. Opportunities, in that there will be even greater impetus for merchants to install appropriate readers but also threats arising from competition out of unexpected quarters. For example, Google is tying its mobile phone operating system to its Google Checkout service – widespread adoption of this system would bypass the fees collected from merchants for processing transactions (Ray, 2011).

8 Conclusions

This paper has endeavoured to set out the terrain of current academic research into consumers' dispositions towards contactless payment cards. By detailing the historical development of payment technologies and the possibilities that are promised by recent innovations, we demonstrate that contactless cards have the potential to play a major role in the low-value transaction market in the future. The cards offer a number of possible benefits to consumers, merchants, banks and governments which are considered here. The history of the evolution of the technological specifications has been outlined together with a summary of how commentators see their future development. This is considered in both a general global context and more specifically within that of the Polish banking sector. Existing data on the state of contactless technology identified Poland as one of the European pioneers in bringing this product to the consumer. Considering the issue from this perspective, there will be much for potential participants in other markets to learn from this example.

Our study draws upon a large, representative sample of Polish respondents, assembled with the assistance of the National Bank of Poland and interviewed by professional canvassers using CAPI protocols. Using this dataset we were able to both test the theoretical predictions of the TAM and evaluate the intentions of different demographic sections of Polish society. Our empirical implementation rests upon the ordered Logit approach appropriate for modelling ordinal and discrete dependent variables. We are able to conclude that the TAM framework provides an accurate depiction of reality and that education level and marital status are strong predictors of the behavioural intention to use contactless cards. It appears that time spent in formal learning correlates with facility towards newer technologies and that singles are more likely to be early adopters.

There are some caveats that should be borne in mind. Every country has its own unique culture and traditions. Poland, a country that emerged from communist rule, still has an unusually high dependence on cash transactions compared to Western Europe and North America. The more limited use of debit and credit cards also suggests that there might be greater novelty in the dispersion of contactless cards. It therefore seems that for greater surety as to the generalisability of our findings, similar studies could be recreated across a diverse range on countries. Similarly, a broader range of explanatory variables may deepen our understanding of the factors influencing intentions and adoption. In addition, we should like to point out that Davis's TAM model is not the only theoretical framework that is potentially capable of explaining the behaviour of future users. We would encourage other researchers to explore other theories and models.

However, despite these qualifications, we believe that this study confirms that, given the right impetus, contactless payment cards certainly have the potential to eat away at the current dominance of cash in low-value transactions. The market definitely appears to be primed for that push. Since Visa, MasterCard and American Express have effectively established the standard for the technology, the risks of entry and costs of investment for banks are limited. In addition, this enables both banks and acquirers to gain the necessary experience and to build the infrastructure, which is likely to be used in the next few years with the development of NFC mobile payments. Finally, in developing and emerging economies, these cards in their pre-paid form are likely to bring financial services to the unbanked.

Acknowledgements

This work was supported by the Polish Ministry of Science and Higher Education through Grant No. N N113 308835. The survey data collection was financed by the Payment Systems Department of the National Bank of Poland. The authors would also like to thank two anonymous reviewers for their constructive comments and Krzystof Maciejewski for his help to design the questionnaires. Tomasz Piotr Wisniewski would like to acknowledge the support of the University of Leicester's sabbatical scheme.

References

Agarwal, R. and Prasad, J. (1999) 'Are individual differences germane to the acceptance of new information technologies?', *Decision Sciences*, Vol. 30, No. 2, pp.361–391.

Al-Gahtani, S. (2001) 'The applicability of TAM outside North America: an empirical test in the United Kingdom', *Information Resources Management Journal*, Vol. 14, No. 3, pp.37–46.

Amin, H. (2007) 'An analysis of mobile credit card usage intentions', *Information Management and Computer Security*, Vol. 15, No. 4, pp.260–269.

Barclays Bank (2010) *Britain Isn't Queuing*, August, Barclays Bank Press Releases.

Bartel, A.P. and Lichtenberg, F.R. (1987) 'The comparative advantage of educated workers in implementing new technology', *The Review of Economics and Statistics*, Vol. 69, No. 1, pp.1–11.

Bàtiz-Lazo, B. and Wardley, P. (2007) 'Banking on change: information systems and technologies in UK high street banking 1919–1969', *Financial History Review*, Vol. 14, No. 2, pp.177–205.

Bàtiz-Lazo, B. and Wood, D. (2002) 'A historical appraisal of information technology in commercial banking', *Electronic Markets*, Vol. 12, No. 3, pp.192–205.

Bohl, M., Havrylchyk, O. and Schiereck, D. (2006) 'Foreign acquisition and industry wealth effects of privatization: evidence from the polish banking industry', in Balling, M., Liermann, F. and Mullineux, A. (Eds.): *Competition and Profitability in European Financial Services*, pp.80–95, Routledge, New York.

Bolt, W. and Humphrey, D. (2007) 'Payment network scale economies, SEPA, and cash replacement', *Review of Network Economics*, Vol. 6, No. 4, pp.453–473.

Bolt, W., Jonker, N. and Van Renselaar, C. (2009) 'Incentives at the counter: an empirical analysis of surcharging card payments and payment behavior in the Netherlands', *Journal of Banking and Finance*, Vol. 34, No. 8, pp.1738–1744.

Borooah, V.K. (2002) *Logit and Probit: Ordered and Multinomial Models*, Sage, Thousand Oaks, CA.

Borzekowski, R. and Kiser, E.K. (2008) 'The choice at the checkout: quantifying demand across payment institutions', *International Journal of Industrial Organization*, Vol. 26, No. 4, pp.889–902.

Bradford, T. and Hayashi, F. (2007) *Complex Landscapes: Mobile Payments in Japan, South Korea and United States*, September, Payment System Research Briefing, Federal Reserve Bank of Kansas City, Kansas City, KS.

Brits, H. and Winder, C. (2005) *Payments are No Free Lunch*, Vol. 3, No. 2, DNB Occasional Study, De Nederlandsche Bank, Amsterdam.

Buchanan, B. (2004) 'Money-laundering – a global obstacle', *Research in International Business and Finance*, Vol. 18, No. 1, pp.115–127.

Capizzi, M.T. and Ferguson, R. (2005) 'Loyalty trends for the twenty-first century', *Journal of Consumer Marketing*, Vol. 22, No. 2, pp.72–80.

Carow, K.A. and Staten, M.E. (1999) 'Debit, credit, or cash: survey evidence on gasoline purchases', *Journal of Economics and Business*, Vol. 51, No. 5, pp.409–421.

Central Statistical Office (2010) *Labour Force Survey in Poland, II Quarter 2010*, Warsaw, available at http://www.stat.gov.pl (accessed on 23 March 2011).

Chakravorti, S. (2003) 'Theory of credit card networks: a survey of the literature', *Review of Network Economics*, Vol. 2, No. 2, pp.50–68.

Choo, K-K.R. (2009) 'Money-laundering and terrorism financing risks of prepaid card instruments', *Asian Journal of Criminology*, Vol. 4, No. 1, pp.11–30.

Churchill, G.A. (1979) 'A paradigm for developing better measures of marketing constructs', *Journal of Marketing Research*, Vol. 16, No. 1, pp.64–73.

Clark, C.L. (2005) 'Shopping without cash: the emergence of the e-purse', *Economic Perspectives* Vol. 29, No. 4, pp.34–51.

Cronbach, L.J. (1951) 'Coefficient alpha and the internal structure of tests', *Psychometrika*, Vol. 16, No. 3, pp.297–334.

Crotty, J. (2009) 'Structural causes of the global financial crisis: a critical assessment of the 'new financial architecture', *Cambridge Journal of Economics*, Vol. 33, No. 4, pp.563–580.

Datamonitor (2010) 'Poland: a new wave of developments will determine the success of contactless cards', *Marketwatch: Financial Services*, Vol. 9, No. 3, p.7.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, Vol. 13, No. 3, pp.319–340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) 'User acceptance of computer technology: a comparison of two theoretical models', *Management Science*, Vol. 35, No. 8, pp.982–1003.

Eastwood, G. (2008) *The Future of Payments: Prepaid Cards, Contactless and Mobile Payments*, 01 April, p.78, Business Insights, Datamonitor.

Economides, N. (1993) 'Network economics with application to finance', *Financial Markets, Institutions and Instruments*, Vol. 2, No. 5, pp.89–97, Farmington, CT.

Eurostat (2010) *Level of Internet Access – Households*, available at http://epp.eurostat.ec.europa.eu/portal/page/portal/information_society/data/main_tables (accessed on 5 January 2012).

Fischer, J. (2009) 'NFC in cell phones: the new paradigm for an interactive world' *Communications Magazine*, Vol. 47, No. 6, pp.22–28, IEEE.

Flier, B., Van den Bosch, F.A.J., Volberda, H.J., Carnevale, C., Tomkin, N., Melin, L., Quelin, B. and Kriger, M. (2001) 'The changing landscape of the european financial services sector', *Long Range Planning*, Vol. 34, No. 2, pp.179–207.

Fornell, C. and Larcker, D.F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, pp.39–50.

Frazer, P. (1985) *Plastic and Electronic Money*, Woodhead-Faulkner, Cambridge.

Gan, C., Clemens, M., Limsombunchai, V. and Weng A. (2006) 'A logit analysis of electronic banking in New Zealand', *International Journal of Bank Marketing*, Vol. 24, No.6, pp.360–383.

Garcia-Schwartz, D.D., Hahn, R.W. and Layne-Farrar, A. (2006) 'The move toward a cashless society: a closer look at payment instrument economics', *Review of Network Economics*, Vol. 5, No. 2, pp.175–198.

Gebhart, M., Eber, W., Winkler, W., Kovac, D. and Krepelka, H. (2008) 'From power to performance in 13.56 MHz contactless credit card technology', *6th International Symposium on Communication Systems, Networks and Digital Signal Processing*, 25–25 July, pp.301–305.

Gerrard, P., Cunningham, J.B. and Devlin, J.F. (2006) 'Why consumers are not using internet banking: a qualitative study', *Journal of Services Marketing*, Vol. 20, No. 3, pp.160–168.

Górka, J. (2009) *Konkurencyjnosc Form Pieniadza I Instrumentow Platniczych*, CeDeWu, Warsaw.

Gowrisankaran, G. and Stavins, J. (2004) 'Network externalities and technology adoption: lessons from electronic payments', *RAND Journal of Economics*, Vol. 35, No. 2, pp.260–276.

Gresvik, O. and Haare, H. (2009) *Costs in the Norwegian Banking System*, Working Paper No. 4, Norges Bank, Oslo.

Grzywacz, J. (2004) *Bankowość Elektroniczna w Działalności Przedsiębiorstw*, Szkoła Główna Handlowa w Warszawie – Oficyna Wydawnicza, Warszawa.

Gu, J-C., Lee, S-C. and Suh, Y-H. (2009) 'Determinants of behavioral intention to mobile banking', *Expert Systems with Applications*, Vol. 36, No. 9, pp.11605–11616.

Guibourg, G. and Segendorff, B. (2007) 'A note on the price- and cost structure of retail payment services in the Swedish banking sector 2002', *Journal of Banking and Finance*, Vol. 31, No. 9, pp.2817–2827.

Hair, J.F., Jr., Tatham, R.L. and Black, W.C. (1998) *Multivariate Data Analysis*, 5th ed., Prentice-Hall, Englewood Cliffs, NJ.

Halek, M. and Eisenhauer, J.G. (2001) 'Demography of risk aversion', *The Journal of Risk and Insurance*, Vol. 68, No. 1, pp.1–24.

Hancke, G. (2008) 'RFID and contactless technology', in Mayes, K.E. and Markantonakis, K. (Eds.): *Smart Cards, Tokens, and Security Applications*, Springer, New York.

Hoffmann, A., Wörlen, H., Friedrich, A., Knaust, N., Von Kalckreuth, U. and Schmidt, T. (2009) *Payment Behaviour in Germany*, 30 June, Deutsche Bundesbank, available at http://www.bundesbank.de/presse/presse_aktuell.en.php (accessed on 10 January 2011).

Hooley, G.J. and Saunders, J. (1993) *Competitive Positioning: The Key to Market Success*, Prentice Hall, Hemel Hempstead.

Im, S., Bayus, B.L. and Mason, C.H. (2003) 'An empirical study of innate consumer innovativeness, personal characteristics, and new-product adoption behavior', *Journal of the Academy of Marketing Science*, Vol. 31, No. 1, pp.61–73.

Issing, O. (2009) 'Some lessons from the financial market crisis', *International Finance*, Vol. 12, No. 3, pp.431–444.

Jamieson, B. and Rogers, W. (2000) 'Age-related effects of blocked and random practice schedules on learning a new technology', *Journals of Gerontology: Psychological Sciences and Social Sciences*, Vol. 55, No. 6B, pp.343–353.

Jonker, N. (2007) 'Payment instruments as perceived by consumers – results from a household survey', *De Economist*, Vol. 155, No. 3, pp.271–303.

Katz, M.L. and Shapiro, C. (1985) 'Network externalities, competition, and compatibility', *American Economic Review*, Vol. 75, No. 3, pp.424–440.

Kim, C., Mirusmonov, M. and Lee, I. (2010) 'An empirical examination of factors influencing the intention to use mobile payment', *Computers in Human Behavior*, Vol. 26, No. 3, pp.310–322.

Kisiel, M. (2007) *Internet a Konkurencyjność Banków w Polsce*, CeDeWu, Warszawa.

Kiwior, J. (2010) 'Karta Visa zaplacisz wszedzie', *Central European Electronic Card, Visa Conference Presentation*, 2 December, Warsaw.

Klee, E. (2008) 'How people pay: evidence from grocery store data', *Journal of Monetary Economics*, April, Vol. 55, No. 3, pp.526–541.

Kountz, E. and Laszlo, J. (2007) *Contactless Payments: Global Strategy Seeks to Secure High-Potential Markets*, Forrester Research, Cambridge, MA.

Kuznets, S. (1930) *Secular Movements in Production and Prices*, Houghton Mifflin, Boston, MA.

Lee, L.S., Fiedler, K.D. and Smith, J.S. (2008) 'Radio frequency identification (RFID) implementation in the service sector: A customer-facing diffusion model', *International Journal of Production Economics*, Vol. 112, No. 2, pp.587–600.

Lee, M-C. (2009) 'Predicting and explaining the adoption of online trading: an empirical study in Taiwan', *Decision Support Systems*, Vol. 47, No. 2, pp.133–142.

Lefebre, P.J. (1999) 'Digital money – a view from the European Commission', *European Business Review*, Vol. 99, No. 4, pp.242–256.

Leinonen, H. (2008) 'Payment habits and trends in the changing e-landscape 2010+', *Expository Studies*, A, p.111, Bank of Finland, Helsinki.

Levitin, A.J. (2007) 'Payment wars: the merchant-bank struggle for control of payment systems', *Stanford Journal of Law Business and Finance*, Vol. 12, No. 2, pp.1–66.

Lewis-Beck, M.S. (Ed.) (1994) *Factor Analysis and Related Techniques*, Sage, London.

Liebowitz, S.J. and Margolis, S.E. (1994) 'Network externality: an uncommon tragedy', *Journal of Economic Perspectives*, Vol. 8 No. 2, pp.133–150.

Likert, R. (1932) 'A technique for the measurement of attitudes', *Archives of Psychology*, Vol. 22, No. 140, pp.1–55.

Long, J.S. (1994) 'Confirmatory factor analysis: a preface to LISREL', in Lewis-Beck, M.S. (Ed.), *Factor Analysis and Related Techniques*, pp.247–328 Sage, London.

Mackenzie, D. (2011) 'The credit crisis as a problem in the sociology of knowledge', *American Journal of Sociology*, Vol. 116, No. 6, pp.1778–1841.

Maison, D. (2010) *Postawy Polaków wobec obrotu bezgotówkowego*, 15 March, Narodowy Bank Polski, Raport, Warszawa, available at http://www.nbp.pl (accessed on 12 January 2012).

Mathieson, K. (1991) 'Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior', *Information Systems Research*, Vol. 2, No. 3, pp.173–191.

Mayes, K. and Markantonakis, K. (Eds.) (2008) *Smart Cards, Tokens, and Security Applications*, Springer, New York.

Morris, M.G. and Venkatesh, V. (2000) 'Age differences in technology adoption decisions: implications for a changing work force', *Personnel Psychology*, Vol. 53, No. 2, pp.375–403.

Muller-Seitz, G., Dautzenberg, K., Creusen, U. and Stromereder, C. (2009) 'Customer acceptance of RFID technology: evidence from the German electronic retail sector', *Journal of Retailing and Consumer Services*, Vol. 16, No. 1, pp.31–39.

National Bank of Poland (2007) *Summary Evaluation of the Financial Situation of Polish Banks – 2006*, available at http://www.nbp.pl/Homen.aspx?f=en/publikacje/o_nadzorze_bankowym/wyniki.html (accessed on 5 January 2012).

National Bank of Poland (2008) *Obrót Bezgotówkowy – Zalety i Korzyści Wynikające z Jego Upowszechnienia,* available at http://www.nbp.pl/SystemPlatniczy/Obrot_bezgotowkowy/Obrot_bezgotowkowy_2008.pdf (accessed on 5 January 2012).

National Bank of Poland (2009) *Rozwój systemu finansowego w Polsce [The development of the financial system in Poland]*, Department of Financial Systems, Warszawa.

National Bank of Poland (2010a) *Liczba bankomatów liczba i wartość transakcji dokonanych w bankomatach w kolejnych kwartałach od 1999 roku*, Payment system Department, Warsaw, available at http://www.nbp.pl/systemplatniczy/karty/bankomaty.xls (accessed on 5 January 2012).

National Bank of Poland (2010b) *Liczba wyemitowanych kart płatniczych na przestrzeni kolejnych kwartałów w latach 1998–2009*, Payment system Department, Warsaw, available at http://www.nbp.pl/systemplatniczy/karty/karty_emisja.xls (accessed on 5 January 2012).

Nielsen (2010) *Global Trends in Online Shopping: A Nielsen Global Consumer Report*, June, available at http://www.nielsen.com (accessed on 16 February 2011).

Olsen, C. (2008) 'Is contactless payment a reality for the retail industry?', *Card Technology Today*, Vol. 20, Nos. 11–12, pp.10–11.

Parasuraman, A. (2000) 'Technology readiness index (TRI): a multiple-item scale to measure readiness to embrace new technologies', *Journal of Service Research*, Vol.2, No. 4, pp.307–320.

Phelps, C.W. (1947) *Retail Credit Fundamentals*, McGraw-Hill, New York.

Pikkarainen, T., Pikkarainen, K., Karijaluoto, H. and Pahnila, S. (2004) 'Customer acceptance of on-line banking: an extension of the technology acceptance model', *Internet Research*, Vol. 14, No. 3, pp.224–235.

Polasik, M. (2007) *Bankowość elektroniczna. Istota – stan – perspektywy*, CeDeWu, Warsaw.

Polasik, M. and Maciejewski, K. (2009) 'Innowacyjne usługi płatinicze w Polsce in na świecie', August, Working Paper No. 241, National Bank of Poland, Warsaw.

Polasik, M., Górka, J., Wilczewski, G., Kunkowski, J., Przenajkowska, K. And Tetlowska, N. (2011a) *Time Efficiency of Point-of-Sale Payment Methods: The empirical Results for Cash, Cards and Mobile Payments*, available at http://ssrn.com/abstract=1769922 (accessed on 30 June 2011).

Polasik, M., Starogarska, E., Kunkowski, J. and Maciejewski, K. (2011b) *The Global Contactless Payment Cards Market: Market Development, Opportunities and Perspectives*, Polasik Research, Torun.

Polasik, M., Kunkowski, J. and Maciejewski, K. (2009) *Rynek Bezstykowych Kart Płatniczych w Polsce I na Świecie*, Polasik Research, Toruń.

Polish Bank Association (2004) *Udział Banków na Rynku Usług Elektronicznych*, May, Unpublished manuscript, Warszawa.

Polish Bank Association (2006) *Informacja nt. Liczby i Aktywności Klientów Bankowości Elektronicznej*, December, Unpublished manuscript, Warszawa.

Polish Bank Association (2010) *Informacje nt. liczby i aktywności klientów bankowości elektronicznej*, Dane statystyczne Związku Banków Polskich, Warszawa.

Quaden, G. (2005) *Coûts, avantages et inconvenient des different moyens de paiement*, Décembre, Rapport, Banque Nationale de Belgique, Brussels.

Quah, J.T.S. and Sriganesh, M. (2008) 'Real-time credit card fraud detection using computational intelligence', *Expert Systems with Applications*, Vol. 35, No.4, pp.1721–1732.

Rae, C. (2005) 'MasterCard and Visa agree contactless payments protocol', *Card Technology Today*, April, Vol. 17, No. 4, p.4.

Ray, W. (2011) 'Google readies 2011 pay-by-wave for Nexus S wallet chip', *The Register*, 05 January, available at http://www.theregister.co.uk/2011/01/05/google_nfc/.

Reischmann, K.C. and Miller, F.T. (2007) 'How safe is personal and financial data with financial institutions and banks?', in Larsen, K.R. and Voronovich, Z.A. (Eds.): *Privacy in a Transparent World*, pp.14–23, Ethica Publishing, Boulder, Colorado.

Rieback, M.R., Crispo, B. and Tanenbaum, A.S. (2006) 'The evolution of RFID security', *IEEE Pervasive Computing*, Vol. 5, No. 1, pp.62–69.

Riem, A. (2001) 'Cybercrimes of the 21st century: crimes against the individual – part 1', *Computer Fraud and Security*, Vol. 2001, No. 6, pp.13–17.

Ritzer, G. (1995) *Expressing America: A Critique of the Global Credit Card Society*, Pine Forge Press, Thousand Oaks, CA.

Rochet, J-C. and Tirole, J. (2003) 'Platform competition in two-sided markets', *Journal of the European Economic Association*, Vol. 1, No. 4, pp.990–1029.

Rogers, E.M. (1962) *Diffusion of Innovation*, Free Press, New York.

Roh, J.J., Kunnathur, A. and Tarafdar, M. (2009) 'Classification of RFID adoption: an expected benefits approach', *Information and Management*, Vol. 46, No. 6, pp.357–363.

Satterthwaite, F.E. (1946) 'An approximate distribution of estimates of variance components', *Biometrics Bulletin*, Vol. 2, No. 6, pp.110–114.

Schierz, P.G., Schilke, O. and Wirtz, B.W. (2010) 'Understanding consumer acceptance of mobile payment services: an empirical analysis', *Electronic Commerce Research and Applications*, Vol. 9, No. 3, pp.209–216.

Schneider, F. (2002) *Size and Measurement of the Informal Economy in 110 Countries around the World*, Rapid Response Unit, The World Bank, Washington, DC.

Schneider, F. (2005) 'Shadow economies around the world: what do we really know?', *European Journal of Political Economy*, Vol. 21, No. 3, pp.598–642.

Schuh, S. and Stavins, J. (2010) 'Why are (some) consumers (finally) writing fewer checks? The role of payment characteristics', *Journal of Banking & Finance*, Vol. 34, No. 8, pp.1745–1758.

Shin, D-H. (2009) 'Towards an understanding of the consumer acceptance of mobile wallet', *Computers in Human Behavior*, Vol. 25, No. 6, pp.1343–1354.

Smart Card Alliance (2006) *Contactless Payments: Consumer Attitudes and Acceptance in the United States*, November, A Smart Card Alliance and Javelin Strategy and Research Report, http://www.smartcardalliance.org/pages/publications-contactless-payments-attitudes-acceptance/ (accessed on 15 September 2009).

Stavins, J. (2001) 'Effect of consumer characteristics on the use of payment instruments', *New England Economic Review*, No. 3, pp.19–31.

Stender, M. and Schosheim, G. (2007) 'The dangers of credit card skimming in restaurants', in Larsen, K.R. and Voronovich, Z.A. (Eds.): *Privacy in a Transparent World*, pp.24–30, Ethica Publishing, Boulder, Colorado.

Stockman, H. (1948) 'Communication by means of reflected power', *Proceedings of the IRE*, pp.1196–1204.

Van Bossuyt, M. and Van Hove, L. (2007) 'Mobile payment models and their implications for NextGen MSPs', *The Journal of Policy, Regulation and Strategy*, Vol. 9, No. 5, pp.31–43.

Van Hove, L. (1999) 'Electronic money and the network externalities theory: lessons for real life', *Netnomics*, Vol. 1, No. 2, pp.137–171.

Venkatesh, V., Morris, M.G. and Ackerman, P.L. (2000) 'A longitudinal field investigation of gender differences in individual technology adoption decision-making processes', *Organizational Behavior and Human Decision Processes*, Vol. 83, No. 1, pp.33–60.

Visa (2010a) 'Program Karta Visa zaplacisz wzedzie', *Visa Quarterly*, Vol. 6, p.5.

Visa (2010b) 'Visa Cards accepted everywhere', *Visa Europe in the News*, June, available at https://www.cms.eu.visaonline.com (accessed on 3 January 2011).

Von Kalckreuth, U., Schmidt, T. and Stix, H. (2009) *Choosing and Using Payment Instruments: Evidence from German Micro-Data*, December, European Central Bank Working Paper Series, No. 1144.

Walker, D.A. (1996) 'Commercial banks' role in privatization: the case of Poland', *Managerial Finance*, Vol. 22, No. 10, pp.1–17.

Wang, Y. (2008) 'Determinants affecting consumer adoption of contactless credit card: an empirical study', *CyberPsychology and Behavior*, Vol. 11, No. 6, pp.687–689.

Ward, M. (2006) 'EMV card payments: an update', *Information Security Technical Report*, Vol. 11, No. 2, pp.89–92.

Welch, B.L. (1947) 'The generalization of 'student's' problem when several different population variances are involved', *Biometrika*, Vol. 34, No. 12, pp.28–35.

Wolfe, D. (2010) 'Has 'tap and go' come and gone?', *American Banker*, Vol. 175, No. 303, pp.1–11.

Woodward, K. (2010) 'Polish test for contactless cards', *American Banker*, 18th June, Vol. 175, No. F323, p.5.

Worthington, S. (1995) 'The cashless society', *International Journal of Retail and Distribution Management*, Vol. 23, No. 7, pp.31–40.

Worthington, S. (2009) 'Debit cards and fraud', *International Journal of Bank Marketing*, Vol. 27, No. 5, pp.400–402.

Wu, N.C., Nystrom, M.A., Lin, T.R. and Yu, H.C. (2006) 'Challenges to global RFID adoption', *Technovation*, Vol. 26, No. 12, pp.1317–1323.

Notes

1 A 'traditional debit card' is defined here as one that operates with contact technology (magnetic stripe or EMV).

2 There are possible many models of mobile payments; see: Van Bossuyt and van Hove (2007).

3 This resulted in a sample of 694 for traditional debit card analysis and 581 for contactless. The summary statistics reported later in this section indicate that these sub-samples are still representative.

4 Readers interested in learning more about confirmatory factor analysis are directed towards Lewis-Beck's (1994) edited collection.

5 Detailed results of this test can be obtained from the authors on request.

6 The variable *Perceived_Usefulness* has been regressed against *Perceived_Ease_of_Use* using the ordinary least squares (OLS) method. The collected residuals from this regression have been subsequently used as an explanatory variable in model (5).